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ELEMENTS

OF

PERSPECTIVE DRAWING;

OR THE

Science of Delineating Real Objects.

BEING

A MANUAL OF DIRECTIONS FOR USING A SET OF MODELS COMPOSING
A VARIETY OF PICTURESQUE FORMS,

SUITABLE FOR THE PRACTICE OF BEGINNERS.

DESIGNED

BY AUGUSTUS DEACON.

ILLUSTRATED WITH EIGHT PLATES.

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PREFACE.

The purpose of the following pages is to inculcate the advantages attending the study of Form by means of Delineation, and to lay down the scientific principles according to which Drawing may be taught to every one. The course of instruction is entirely rudimental; it being designed for beginners and young persons, and adapted to the use of parents as well as professional teachers. Its aim is to lay a ground-work of exact knowledge and manual dexterity, such as any child may acquire, preparatory to the more advanced stage of sketching from nature, where the tuition of an experienced master is requisite.

The leading feature of this method of teaching is the substitution of solid forms in place of sketches or prints for the learner to copy; thus rendering Drawing practically useful in the outset, and converting the lead-pencil into an instrument for guiding the understanding to a correct perception of the forms and proportions of objects.

The theory on which this plan of instruction is based, as set forth in the Introduction, is briefly this: that knowledge of the principles of delineation, and understanding of the forms of objects, constitute the body of science in the art of Design; the eye and the hand being only the executive members, as genius is the soul: —to exercise the mental faculties, while training the hand of the pupil, is the main object of this system.

The use of models is becoming prevalent among private teachers, as well as in public schools in this country; while, on the Continent, especially in the government schools of France and Germany, models have been used for some time past: it is hoped, therefore, that this attempt to extend and facilitate the practice of instruction by means of models, and to promote the study of Drawing as a branch of general education, will be favourably received by the public.

The set of models which this little manual is intended to accompany, consists of 57 pieces, contained in a box, whose dimensions are,—in length, 18 inches; breadth, 12¾ inches; height, 8¼ inches: their size may be calculated by the scale of the cube No. 1 in Plate 2, which is six inches square; the figures in the plates being in the same proportion. They will be found most convenient for individual pupils and small classes in private schools and families; for public schools, where the classes are numerous, models on a much larger scale would be necessary. In designing the figures, only the simplest forms of regular solids have been included; such as the cube, cone, sphere, pyramid, cylinder, &c.; these, however, may be combined so as to produce groups bearing some resemblance to actual objects; as houses, castles, bridges, steps, crosses, pillars, &c. The figures in plates 7 and 8, represent only a few combinations, which first occurred to the draughtsman: the models are indeed susceptible of a great variety of groupings; and the invention of new figures will afford an amusing exercise for the pupil's ingenuity. The introduction of minute details and complicated figures has been studiously avoided, as being unsuited to the practice of beginners.

When this rudimental course of linear drawing has been gone through in a satisfactory manner, the pupil will be competent to attempt the delineation of any object of fixed form; such as articles of furniture, pottery, implements, buildings, ornaments, &c. But previously to drawing from nature, an insight into the art of sketching should be obtained from a competent master; for skill in selecting those leading points on which the characteristics of objects depend, so as to convey a distinct idea of them by a few significant touches, is most readily acquired by practice under the personal direction of an experienced artist. The exact knowledge and manual dexterity previously acquired, and above all the habit of attentively regarding and thoroughly comprehending the object before him, will materially facilitate the student's progress in picturesque drawing: the degree of proficiency will, of course, depend upon his natural feeling and taste, as well as on the skill of the master. Without going beyond this elementary course, however, the pupil will have acquired sufficient aptitude in using the pencil to enable him to convey an intelligible idea of the shape, structure, and relative proportions of common objects; and also to detect the external characteristics of things with readiness and nicety.

The writer's share in the production of this publication is limited to a suggestion of the plan, and the enunciation of the principles on which it is founded in the introduction; for the details of instruction, and the design of the models, he is indebted to his friend Mr. Augustus Deacon, whose zeal and ability in carrying out his views the author gladly takes this opportunity of acknowledging.

W. S. W.

VICARAGE PLACE, KENSINGTON,
July 1841.

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INTRODUCTION.

THE advantages of being able to draw are manifold; but they are in general not sufficiently understood. Drawing has been too commonly regarded as an elegant accomplishment and an agreeable pastime, serviceable only when pursued as a profession, and attainable but by the gifted few. This is a limited and erroneous idea; and it is happily giving way to a more sound and enlarged view of the subject. The necessity for teaching drawing to artisans is now generally admitted, and its importance as a branch of national education is so far recognised, that there can be little doubt but that it will form a branch of the plan of education to be adopted in the Government schools. A knowledge of drawing is useful, however, not only to artists and mechanics, but to all classes of persons: to the man of leisure it offers a delightful recreation, and to the man of business it affords a real benefit, of practical utility in the every-day concerns of life. The degree of knowledge and skill necessary to make use of it for ordinary purposes may be easily acquired in a comparatively short time, by any one having the use of his faculties, if properly taught: in short, it may be affirmed as a general proposition, that any one who can write can learn to draw; and the time is not far distant, it is to be hoped, when drawing will become an equally essential part of a common education. To conduce to this desirable result is the object of these pages, and of the set of models intended to accompany them.

Drawing is the art of representing the forms of solid objects on a flat surface by means of lines; hence it is termed delineation. In order to delineate any object correctly, it is necessary first to understand its form thoroughly, and to know the way in which its appearance is to be copied so as to convey an accurate idea of the reality. This constitutes the *science* of drawing, which is the most valuable part, and equally attainable by all: on a proper acquaintance with the science of form depends the accuracy of the delineation. To draw lines representing the object is the first step in the *art* of delineation; and even in this rudimental exercise of skill, the various degrees of taste and manual dexterity in different persons are shown by the relative neatness, spirit, and facility of their respective performances.

This division of drawing into its two component parts, viz.

I.—THE SCIENCE OF FORM,
II.—THE ART OF DELINEATION,

is important to be borne in mind. The effect of not marking the distinction between them has been a confusion of ideas on the subject, resulting in the prevalent opinion that the same kind of talent is required to draw the outline of a square box as to paint a fine picture; and the consequence has been that the course of instruction generally pursued has tended to make a few bad and inefficient artists, instead of a number of good delineators or draughtsmen. Pupils have been directed to copy the sketches of teachers, instead of being taught to draw actual objects; hence they have become mere imitators of another's style or manner of drawing, and have attained proficiency in this limited accomplishment only after a long course of practice. Some knowledge of the principles or science of drawing was subsequently imparted, but often superficially; and before attaining this point, the majority of learners had given up a course of practice in which they were not likely to excel, and which seemed to lead to no really useful result. In effect, the routine of teaching drawing hitherto adopted is as absurd as it would be to instruct children to express themselves properly by setting them to imitate the style of Johnson or Gibbon before they know anything of grammar.

The analogy between drawing and written composition is indeed complete; for delineation is the language of form; and by its means alone are exact ideas of the shape and size of objects to be expressed. It is necessary for every one, therefore, to be able to draw, in order to convey to others any correct idea connected with the forms of things. Shape cannot be expressed by words, though size may by figures; it must be represented by lines: consequently the use of the pencil is as necessary as the pen, to a free and explicit intercommunication of thoughts. We cannot explain the plan of a house, the fashion of an ornament, the form of an implement or of a piece of furniture, the direction of a route, the shape and proportion of anything, without the power of delineation; yet so accustomed are people to call in the aid of a professional draughtsman upon important occasions, and to be content with conveying an imperfect idea or none at all in ordinary cases, that they are scarcely conscious of the fact of being unable to express their meaning without the aid of an interpreter; who is, moreover, often himself at a loss to help them because they cannot make themselves understood to him. How often has it happened that the idea of some design for a vase, a scroll, a monumental tablet, an ornamental edifice—or a recollection of the proportions of some fine temple, or of the features of some departed or absent friend, is lost for want of the ability to put to paper the image existing in the mind! Drawing is a universal language, intelligible to people of every country, and all ages; besides being the only one by which a certain class of ideas can be expressed: a few lines drawn with skill and purpose convey a meaning that pages of written description fail to express.

Nor is the power of conveying with facility a particular class of ideas the only advantage arising from being able to draw. Apart from the necessity for expressing such ideas, a knowledge of drawing is essential to forming an accurate conception of them. The possession of this knowledge adds very greatly to the sum of our common enjoyments; for its attainment is the means of quickening and correcting the perception, and rendering the mind more alive to the beauties of form in objects, their relative proportions, and other external characteristics. Further, it enables the memory to retain the impressions of vision longer; because the habit of attention, promoted by the practice of drawing, renders them more vivid and thoroughly intelligible. Delineation is to the recollection of the shapes of things what writing is to the verbal memory; the very act of recording what we see, hear, or read, impresses it more strongly on the mind.

The study of form, in particular, is an essential part of the education of the eye; the apt expression "he has got a painter's eye," is commonly applied to persons gifted by nature, or trained by habit to perceive the picturesque points of common scenes, and to discriminate the characteristics of objects. Drawing has been defined to mean *clear*-seeing: it is *intelligent*-seeing; for the understanding is cultivated as well as the sense; and the power of delineating what we see is obtained. In order fully to appreciate the value and importance of a knowledge of the science of form in training the perceptive faculty, it is necessary to analyse the formation of our ideas of external objects. The eye is the camera obscura of the brain: the external lens is the object-glass receiving the rays of light, and transmitting the luminous image on to the retina; when thus depicted on the tablet in the visual chamber, it becomes the property of the mind: if the brain chooses to retain it, well; if not, another picture painted with the pencil of light momentarily succeeds, and effaces the transient impression; and so the delicate and beautiful mechanism of sight continues to perform its delightful office of presenting to the brain an endless and rapid succession of ever-varying scenes and objects, with unerring fidelity and unceasing activity; unless the organ be impaired by disease. The common phrases, "a quick eye," "an accurate eye," are apt to mislead: every eye in a healthy state is quick and accurate. It is the understanding that is slow and imperfect; imperfect, because it does not take the time and pains requisite completely to comprehend the characteristic features of the image formed on the retina: upon the degree of attention bestowed on these evanescent pictures depend the perfectness and durability of the ideas of external things with which the memory is stored, the understanding enriched, and the fancy enlivened. The intellectual operation may be likened to the chemical process by which the photographic pictures are rendered permanent: it is this which resolves the fleeting visions of the outward sense into distinct and lasting ideas of the mind. In default of this mental process, too many of our fellow-creatures go through life almost insensible to the sources of enjoyment continually presented to them: having eyes, they see not; or, "seeing, they see, and do not perceive:" "their eyes are open, but their sense is shut." The image painted on the retina of the merest dolt that ever gazed on a beautiful prospect is as vivid as that presented to the painter, or the poet; the intellectual comprehension and appropriation make the difference. Hence it is evident that vividness and correctness of perception depend upon the understanding; and the training, or education of the eye, means the discipline of the mind in relation to ocular perceptions.

A knowledge of the laws of perspective, by means of which the appearances of solid forms are delineated on paper, so as to convey a correct idea of the realities, is clearly an operation of the mind. Thus the first and all-important principle of drawing—namely, that the SCIENCE OF FORM *is dependent upon the proper exercise of the understanding*—is demonstrated.

We now come to the consideration of the ART OF DELINEATION; in which the powers of the hand come into operation. And truly the hand is as docile and apt a member as the eye, when it is properly directed by the mind: though, unlike the eye, it only acts when told; and, therefore, requires practice in order to perform its duty dexterously. But who that has seen the juggler catching the rapidly descending balls with one hand, and flinging them up in the air with the other, his eye fixed all the while on one point in the glittering circle described by the revolving balls, can doubt the aptitude of the hand in obeying the mind as directed by the eye? If another proof be required, it is supplied by the familiar instance of the cutting out of profiles in paper: the profilist fixes his eye upon the face, while his hand directs the scissors almost mechanically, only requiring a glance to verify the correctness; or rather, perhaps, to ascertain that the *relative* position of the different features is correct. The influence of the mind in the act of delineation is strikingly shown by the phenomena (if the term may be allowed) of silhouettes. It is a singular fact that, readily as a black profile is cut in paper from the life, it is extremely difficult to copy it with the pen. The reason is this:—the resemblance, consisting in a general similitude of form and proportion, is conveyed by such slight means that a moderate degree of approximation to likeness conveys an impression of identity; yet the most minute deviation from the outline of the silhouette in copying it with the pencil is fatal to the similitude, because in so slender an indication not a trace can be dispensed with. What makes it so difficult for the eye and hand to follow the contour of the silhouette, is that the shadowy image presents so little for the understanding to master; and the hand, therefore, with great difficulty follows the course of the eye, not being sufficiently influenced by the understanding.

Any one who has looked over an accomplished artist sketching from nature, will have observed that his eye is directed much more attentively to the scene or object before him than to his paper; he looks to his drawing chiefly to ascertain that each successive line he traces is properly placed relatively to those previously drawn, and to put in finishing strokes. He has taught his hand to obey him instinctively. So entirely is the perception of form dependent on the understanding, that if the difficulty of placing the several lines in their proper relative positions could be got over, a blind man might be taught to draw a solid object, whose shape he could ascertain by the touch.

Having arrived at the fact that the sense of vision may be dispensed with in the perception of form by the mind, it remains to try if the understanding can be set aside, leaving the eye alone to direct the hand. A cube, or square box, may be so placed before the eye that only one side is presented to view; and supposing the mind to have no cognisance of its real shape, nor any means of ascertaining it, the delineation of its apparent form would not convey an idea of the reality: the same may be said of a cylinder so fore-shortened that only one end is visible. As the eye can only receive an impression from one side of any object at a time, a second view of it, or the evidence of the touch, is requisite to inform the mind of its actual shape and size.

Suppose that an accomplished artist were to see in a foreign country some strange object, with the nature and use of which he was ignorant; that it was not within reach of his hand, and did not afford him another view from a different point: if he were to delineate the apparent form ever so correctly, he would fail to convey a distinct idea of the reality either to one acquainted with its true shape, or to another who was not. The truth is, that the artist depicts not the object or scene itself, but the idea of it in his own mind; and whether that idea is complete and accurate, or not, depends upon the clearness and perfectness of his understanding.

This accounts for the dissatisfaction frequently felt at the labours of many clever artists by persons thoroughly conversant with the form of the objects introduced into pictures, of which the painter has only a picturesque sense. It shows the necessity of artists studying scientifically whatever they portray; for however small and slight the sketch may be, a practised eye at once detects the indications of knowledge or ignorance in the delineation. The surgeon will perceive essential defects in the representation of anatomical structure, or morbid appearances, which escape the unlearned eye: so with the naturalist, in looking at pictures of animals or plants; the architect and the engineer, the sailor and the sportsman, in regard to the drawing of objects with which they are respectively cognisant. On this account it is that skilful draughtsmen commonly devote themselves to the delineation of one particular class of subjects, which they can afford time to study attentively in order to insure characteristic accuracy. As regards the human form, the most difficult to depict correctly, the greatest masters have declared that they never attained the perfection they desired in depicting it; and it formed their constant study, up to the latest day of their lives.

Having thus shown that on the clearness and activity of the understanding depend the vividness and permanency of the impressions of sight, and the exactness of the delineation, it may be conceded that the mind cannot be trained to the discrimination of forms and details by a more efficient course of practice than the study of drawing affords; for though the student of one class of objects may be more deeply versed in them than the painter, the latter will be better acquainted with the external characteristics of other things. Moreover, the artist's study is of picturesque appearances of forms, combinations, and effects: and it is in relation to the external characteristics of scenes and objects that the understanding requires training, in order to profit by the exercise of the eye. The habit of looking at works of art, of comparing their merits, and tracing the impressions their beauties produce on the mind to the proper source, is the best discipline of taste: but the practice of drawing is also of great utility in the study of the æsthetics of art; inasmuch as it serves to exercise and convince the understanding in the perception of the beauties of composition and proportion, as painting does in those of colour and effect. One step in the practice of the art is a vantage-ground, from which a wider view is obtained of the world of beauty around. The prevalent insensibility to inelegances of shape and proportion in our architecture, cabinet-work, pottery, &c.,

and the indifference, if not actual aversion, to the attractions of sculpture, in this country, are traceable to a neglect of the study of form: the defects so frequently observable in the drawing of our painters are unquestionably attributable to their imperfect acquaintance with the human figure. These are questions, however, that open a field for discussion too extended for these pages; sufficient reasons, it is hoped, have already been adduced to convince the reflecting reader of the advantages of a knowledge of drawing, and of the validity of the leading principle herein enunciated—namely, that in the study and delineation of form the understanding is the most important agent.

PRELIMINARY DIRECTIONS.

In order to commence the practice of perspective drawing, the student should be provided with,—1st, a drawing-board about twenty-two inches by sixteen inches, or any more convenient size, made of wood that will not warp, planed quite smooth, with the edges perfectly squared. Upon this board the paper must be fixed at the corners by small tacks or drawing-pins.

2nd. The T. square, which is a flat rule, fixed at right angles into a stock or thicker piece of wood; by sliding the stock of the square up and down the edges of the board, lines may be drawn upon the paper parallel to either side in any position required.

3rd. A pair of compasses with a moveable limb, made so as to admit of a pencil being put in the place of one of the legs. 4th. A parallel ruler, which is an instrument made for the purpose of drawing one line parallel to another. 5th.

Blacklead pencils of various degrees of hardness, H, meaning hard, for drawing the geometrical and perspective problems, and H.B. (hard and black), and B. (black), for sketching the models by the eye.

The box of models will be found to contain the following figures—namely:—A cube (numbered 1); an oblong cube (2); two prisms (3-3); two pieces (4-4) forming a pyramid; two octagonal towers (5-5), with caps (6-6); two cylindrical towers (7-7), with caps (8-8); two small cubes, for bases (9-9); a cone (10); a sphere (11); a semicircular arch (12); three elliptical arches (13-13-13); two centre piers (14-14) for arches; and two end piers (15-15). Nos. 16 to 23 include a number of lesser pieces for forming steps, crosses, battlements, &c., the uses of which will be found in building up the figures in plates 7 and 8.

It may be proper to remind the pupil that great care should be taken in packing and unpacking the models, not to notch the edges; as the beauty of the figures and their utility to the learner depend on the sharpness of the lines: to save trouble, it is advisable, in taking the pieces out of the box, to note the way in which they are packed, as they should be replaced in the same manner.

In arranging the models, to see the effect of the groups, it is desirable that they should be placed so that the eye may be level with the lower part of the figure, about one-third up the column, where the line D.D. intersects figs. 2 and 4, in plate 4; and as much of their picturesqueness depends on the light and shadow, the lower part of the window might be darkened, and the light be admitted obliquely from above.

Being provided with the requisite materials, it is advisable to begin by explaining to the pupil the principles of linear drawing, which is the art of making a representation of a solid object on paper by lines. By placing the cube so that only two sides are visible to the pupil, he will be convinced of the fact, that the apparent shapes of objects differs from their real form: then lower the cube, so that the top also is visible, which will give him a more complete idea of the figure; still the fact of its having two other sides must be inferred from the direction of the lines of the top, for the other three sides cannot be represented at the same time. This will impress upon his mind the fact that only half of any regular object can be seen at once, and that our ideas derived from the delineation of it are formed by the exercise of the understanding; we infer from that portion of the object which is presented to the eye the other part which is not seen.

The art of drawing, therefore, consists in delineating objects in such a manner that the representations of the apparent form shall suggest a correct idea of the real one: and this is accomplished by a knowledge of the rules of perspective.

The science of Linear Perspective is nothing more than a knowledge of the direction which the outlines of objects appear to take as their parts recede from the eye: the direction of lines is evident to the perception, but a knowledge of the rules which determine their direction is necessary to ascertain correctly the precise apparent shape which will indicate the reality. To exemplify this, first place the cube so that only one side is visible; and then so that the top and two sides are visible at once; and let the pupil look at it through a pane of glass, the angle formed by the two sides being opposite his eye. In this position, keeping the eye fixed, he may trace the lines of the cube upon the glass with a little gum-water and whiting; let him verify the correctness of the outline by looking at it again, and remove the cube further from the glass; this will show the effect of distance in diminishing the forms of objects. Then let the lines on the glass be traced on to a sheet of paper, which will illustrate the fact that every correct delineation is a copy of the image presented on an imaginary plane, placed vertically and parallel to the eye of the spectator, and called the plane of the picture. Previously to attempting to draw any solid figure, the pupil should be taught the elementary principles of geometric drawing, which he will easily understand by mastering the following definitions and problems.

In delineating these objects, it is of importance that the lines should be neatly and firmly drawn, and the angles nicely formed. Should the pupil be young, and not accustomed to use the pencil, it may be desirable that he should previously be exercised in drawing outlines from plane figures of geometrical forms, cut out of card-board. This preliminary course of practice will give him a facility of hand that will lessen the difficulty of delineating solid objects when his attention is directed to the study of perspective. He may begin by drawing the various kinds of lines singly, habituating himself to use the pencil boldly, yet not heavily, and to draw the lines in parts as long as the play of the fingers will admit, taking care to join the parts evenly. The practice of drawing the outlines of plane forms is also useful in exercising the eye in perceiving the inclination of lines, and the proportions of different parts of the figure. Plane forms in card-board are preferable to outlines on paper, because the relief of the plane surface makes the outline more distinctly visible; the white of the card-board reflecting the light strongly on the eye, which is thus forcibly impressed by the shape. For young beginners it is advisable to let them rule a base line and a perpendicular to get the figure square: on the base line they should be taught to mark off the width, and on the perpendicular the height of the figure; and those points should be correctly placed before the lines are drawn from point to point. This will simplify the beginning, and prevent that slanting one-sidedness so often seen in the first attempts of tyros.

DEFINITION OF TERMS IN GEOMETRY.

A point, mathematically speaking, has no dimensions in drawing; it is a mark to and from which lines may be drawn (Fig. 1, Plate 1).

A line has only length, and is formed by the union of a number of points (Fig. 2).

A straight or right line is one which makes the shortest distance between two points (Fig. 2).

A curved line is one forming a greater distance between two points (Figs. 3 and 4).

Parallel lines are lines which are equally distant from each other, and if extended to any length would never meet (Figs. 5 and 6).

A horizontal line is one parallel to the horizon.

Diagonal or oblique lines are those which are neither parallel to the horizon, nor at right angles with it (Fig. 7).

A circle is a plane figure formed by one uniform curved line, and is made by placing one leg of the compasses on the paper (as the central point), and describing a line with the other, which line is called the circumference (Fig. 8).

The centre of a circle is a point equally distant from the circumference (c, Fig. 8).

The radius of a circle is a line drawn from the centre to the circumference (c, *a*, Fig. 8).

The diameter of a circle is a line drawn through the centre and terminated on either side by the circumference, as *b*, *c*, Fig. 8.

An arc is any part of the circumference of a circle (*a*, *b*, Fig. 8).

A semicircle is the half of a circle as divided by the diameter.

All circles, large or small, are usually divided into 360 degrees; the half, therefore, is 180 degrees, and the quarter 90 degrees.

An angle is the space contained between two lines meeting in a point, as Fig. 9.

A right angle is one containing 90 degrees, as A or B, Fig. 8.

An obtuse angle is one containing more than 90 degrees, as *a*, C, *c*, Fig. 8.

An acute angle is one containing less than 90 degrees, as *a*, C, *b*, Fig. 8.

A vertical line is one crossing the horizon at right angles, as *d*, *e*, Fig. 8, and *a*, *b*, Fig. 10.

A perpendicular line is one drawn perfectly upright to another, so that the angles on either side are alike, and right angles, as *a*, *b*, Fig. 11. The following is the rule to draw one line perpendicular to another:—

If it be required to draw a line perpendicular to the line *c*, *d*, Fig. 11, and upon the point *e* in that line, take any distance in the compasses and place one leg upon *e*; mark off two points, *c* and *d*, equally distant on each side of *e*; then open the compasses a little wider, and place one leg on *d*, and describe the arc *f*, *a*; now with the same radius describe the arc *g*, *a*, with *c* as a centre, intersecting the other arc in *a*; then draw a line through the points *a*, *e*, which line will be perpendicular to *c*, *d*.

Fig. 12 shows how to divide a given angle into two equal parts; if *a*, *b*, *c*, (Fig. 12,) is an angle to be equally divided, place the compasses on *a*, and describe the arc *d*, *e*, *f*; divide that arc in *e*, through which draw the line *a*, *e*, and the angle is equally bisected.

A triangle is a figure of three sides and angles, as Figs. 1, 2, 3, Plate 2.

An equilateral triangle is one whose sides and angles are equal, as Fig. 1; it may be drawn thus:—If *a*, *b*, is the length of one side, place one leg of the compasses on *b*, and describe an arc from *a* to *c*; perform the same operation with *a* for a centre; the arcs will then intersect at *c*; from *c* draw lines to *a* and *b*, and the figure is complete.

An acute-angled triangle is one which has all its angles acute, as Fig. 2.

An obtuse-angled triangle is one which has one angle of more than 90 degrees, as Fig. 3.

A parallelogram is a figure whose opposite sides are parallel, as Figs. 4 and 5.

When a parallelogram has its angles right angles, it is called a rectangle, as Figs. 4 and 5.

When the sides of a rectangle are equal, it is called a square, as Fig. 4. A square may be drawn thus:—Let *a*, *b*, Fig. 4, be the length of one side; place the leg of the compasses on *a*, and with *a*, *b*, for the radius describe an arc; let the same be done with *b*, as a centre; then draw the perpendicular lines *a*, *c*, and *b*, *d*, and where they intersect the arcs draw the line *c*, *d*, parallel to *a*, *b*, and the figure is complete.

When the two adjacent sides of a rectangle are unequal, it is called an oblong, as Fig. 5.

An octagon is a figure of eight sides, as Fig. 6, and may be drawn thus. First draw a square, *a*, *b*, *c*, *d*; then draw the diagonal lines *a*, *d*, and *c*, *b*; the point where they intersect is the centre of the square; place the leg of the compasses on *d*, and with that as a centre describe the arc *e*, *f*, through the centre of the square; do the same with *c*, *a* and *b*, as centres, and the points where the arcs intersect the line of the square in *e*, *f*, *g*, *h*, &c. will mark the required divisions; connect *h* and *g*, and the other sides similarly, and the figure is complete.

An ellipsis is a plane figure obtained by cutting a cylinder in a line diagonal to its axis, as Fig. 7; *a*, *b* is called the longer diameter, and *c*, *d* the shorter.

To draw an ellipsis (Fig. 8), let *a*, *b* be the long diameter, and *c*, *d* the short one; take a slip of paper and mark off upon it the length of the long diameter, as *e*, *g*; then the shorter diameter, as *e*, *f*; take the piece of paper and place the point *g* upon the short diameter, as *g'*; place the point *f* upon *f'* in the long diameter, and make a point on the paper at *e'*; shift this slip of paper round, keeping the point *f* upon the long diameter, and *g* upon the short one, until a sufficient number of points are obtained; and draw the curve in by hand, as *a*, *c*, *b*.

As it is necessary in order to draw any solid form correctly, to comprehend the principles upon which it is delineated, a knowledge of the science of Perspective is essential. The elementary principles of Perspective are few and simple; and they are exemplified in the following rules for delineating the various forms of which the set of models are composed.

TERMS USED IN PERSPECTIVE.

Appearances of objects. An object has only one form, but a variety of appearances; for instance, the representation of the cube in fig. 1, plate 5, gives a correct idea of a cube if viewed from the proper point, yet not one of the sides are perfectly square, although we know they are all so in reality.

Plan, is the space that any figure would occupy if resting upon the ground.

Elevation, is the geometrical representation of an object, supposing the eye to be level with all parts.

Intersection. When one line is drawn across another, the point where they cross is called the point of intersection.

Visual rays, are rays which are supposed to pass from all objects to the eye, forming a pyramid of rays, of which the object being viewed is the base, and the eye of the observer the apex.—See fig. 9, plate 2, where A is a block to be viewed by an eye at S, the dotted lines representing the rays, and with A for a base they form a pyramid. If the student will examine the cube marked No. 1 in the box of models, he will perceive a small eye or loop of wire at seven of its angles, through which he can draw threads by means of a small needle; if these threads be fastened to the cube, and then collected into a point, they will represent the pyramid of rays passing from the cube to his eye, like the rays in fig. 9, plate 2: and he must here particularly note that a perspective representation of this cube is obtained by imagining a sheet of paper or canvas passing between his eye and the object, and intersecting the rays (see figs. 9 and 10, plate 2); where this intersection takes place, is the true representation of the cube. It may be necessary here to mention that the threads are taken only from each end of the boundary lines of the cube, for convenience; but the student must imagine rays passing from all parts of the object.

Point of sight, or station point, is in the eye of the spectator when viewing an object; the observer should always be placed opposite to this point in viewing a finished picture, for in no other position will a perspective view be seen to advantage.

Transparent plane, or plane of the picture, (sometimes called the plane of representation,) is a transparent flat medium, supposed to pass between the eye of the observer and the object to be viewed, and upon which the representation is to be made (see the plane G, D, C, D, L, in fig. 10, plate 2, and B and C, fig. 9). A picture properly painted and placed in a frame, should have the appearance of an ornamental opening in the wall, through which we can see the real objects.

Angle of vision, is formed by the two extreme rays from the eye, and beyond which no object can be seen: for instance, imagine two rays or rods passing from the eye and making a right angle (containing 90°); if this be the greatest extent of direct vision, any object placed beyond these rays would not be distinctly seen; therefore, in viewing a picture it is necessary to stand at least half its width distant from it.

Ground plane, is the surface of the ground; for convenience supposed to be perfectly level, and upon which (except under particular circumstances) the spectator is supposed to stand.

Base line, or ground line, is the line made by the intersection of the transparent plane upon the ground plane (see G, L, fig. 10, plate 2).

Height of the eye, is the height that the eye is supposed to be from the ground (as S, S, fig. 10, plate 2).

Horizontal line, is a line supposed to pass across the picture parallel to the ground line, and on a level with the spectator's eye (as D, C, D, fig. 10, plate 2).

Vertical line, is a line supposed to pass perpendicularly across the horizontal line, and immediately opposite the eye of the observer (as C, fig. 10, plate 2).

Centre of view, (commonly, though erroneously, called the point of sight,) is a point where the vertical line intersects the horizontal line; a line drawn from this point to the eye would be in every way perpendicular to the plane of the picture (as C, fig. 10, plate 2). To this point all lines that are at right angles to the plane of the picture appear to incline.

Point of distance, is a point on the horizontal line, as remote from the centre of view as the eye (as D and D, fig. 10, plate 2). To this point all lines making an angle of 45° with the picture will appear to incline.

Vanishing points, are points in a picture to which all lines converge that in the original object are parallel to each other.

Parallel perspective. An object is said to be seen in parallel perspective when one of its sides is parallel to the plane of the picture (as plates 3 and 4).

Angular perspective. An object is said to be seen in angular perspective when none of its sides are parallel to the picture (as plate 5, and fig. 1, plate 6).

RULES OF PERSPECTIVE.

PERSPECTIVE is that science by which the appearances of objects from any point of view are represented by geometrical rules, upon a plane surface, real or imaginary.

In order to form a clear idea of the principles upon which this science is founded, imagine a transparent plane, as a sheet of glass, passing between the eye of the spectator and the objects to be viewed. If upon this plane be traced with a little gum-water and whiting the outlines of the objects as they appear to the eye in a fixed position, it is evident that the delineation thus formed will be the true linear representation of the appearance of the objects on the other side of the glass.

Let A, fig. 9, plate 2, be a block of wood, S, the position of the eye of the observer, and B and C, two pieces of glass, the dotted lines representing rays (which, in reality, are not visible) reflected from the object and collected into the eye at S: now, if these rays could pierce holes through the glass as they pass, we should have a faithful representation of the piece of wood; or if the outline were marked on the glass by the spectator with his eye at S, an exact representation of the object would be formed as it appears to him in that situation. If the transparent plane is moved near to his eye, as C, he would have a much smaller representation than if it were placed at B. We have only to imagine the sheets of glass to be sheets of paper, and the principle is clearly demonstrated.

In order to explain it more fully, however, let us go a little deeper into this point, by means of the example, fig. 10, plate 2.

Let *a*, *b*, *c*, *d*, *e*, *f*, and *g*, represent a square block of stone, to be viewed by a spectator at S, with the transparent plane G, L, D, D, placed parallel to the side *d*, *c*, *f*, *g*, of the block, and perpendicular to the ground plane or surface of the ground. If the person viewing the block were to trace upon the transparent plane the appearance of it, the lines in the representation corresponding to *d*, *c*, *f*, *g*, and *a*, *b*, of the object will all be found to be parallel to the base line G, L, where the glass or picture intersects the ground; but the lines on the glass corresponding to *d*, *a*, and *c*, *b*, of the block, appear to incline to a point, C, directly opposite the eye of the observer. Hence we have two general rules—viz., that all lines parallel with the picture will retain the same direction in the perspective representation, and that all lines at right angles to the picture, as *b*, *c*, and *a*, *d*, will appear to incline to a point immediately opposite the eye of the observer, and called the centre of view. It will be observed that rays pass from all visible angles of the object through the glass to the spectator's eye, and it is the intersection of these rays with the picture that gives the perspective representation of the angles: the appearance of the lines *d*, *f*, and *c*, *g*, of the block are obtained by drawing lines from the angles of the block to S, being a point on the ground exactly under the eye of the observer; and where these lines intersect, G, L, perpendiculars are drawn, which represent the angles of the block. The diagonal lines upon the top of the stone, if continued, will appear to incline to the points D, D, on the picture; these being on the horizontal line, and the same distance on each side of C that the eye is from the picture, are therefore called the points of distance.

RULE FOR DRAWING A SQUARE AND CUBE IN PARALLEL PERSPECTIVE.

It is necessary to premise that the student should draw these examples at least three times the size of those in the plate.

Let A and B represent the plan, or situation upon the ground, of two squares, of which a perspective representation is required. First draw the line D, C, D, which represents the situation of the transparent plane upon the ground, as G, L, fig. 10, plate 2; make S the station point, or place of the observer, (like *s*, fig. 10,) plate 2, and draw lines, or rays, from all visible angles of the squares, to S; then draw the lines S, D, parallel to the diagonal lines of the squares. Now draw G, L, parallel to D, C, D, representing the base line of the picture, as G, L, fig. 10, plate 2; then draw S, C, the vertical line, immediately opposite the eye; let the distance, *s*, *c*, be the height of the eye from the ground, and draw *d*, *c*, *d*, the horizontal line, *c* being the centre of view; let fall perpendicular lines from the angles *a* and *b* of the plan of the square, A, and also from the point where the ray from the angle *e* intersects the transparent plane, and where *a* and *b* intersect the base or ground line G, L: draw lines to the centre of view, *c*; and where the perpendicular line from the intersection of the ray *e* with the transparent plane intersects the line *b*, *d*, *a*, in *a* will give the apparent or perspective width of the side *h*, *a*; from *a* draw a line parallel to *e*, *f*, and the perspective representation of the nearest square, A, is complete. In order to prove the accuracy of this performance, it is necessary to try if the diagonal lines, *e*, *a*, and *g*, *f*, incline respectively to the points *d*, *d*, (or points of distance,) on the horizontal line: if so, it is correct. The square B is drawn in precisely the same manner, and will be easily understood by observing the example.

The plans of the two cubes, *c* and D, are the same as the plans of the squares A and B. Study the example, and proceed as before; for a cube is composed of two squares (for the top and under side) connected by perpendicular lines. As neither of these cubes appears to touch the plane of the picture P, *c*, P, it will be necessary to imagine the sides *l*, *g*, and *k*, *h*, to be continued until they do so; now draw down perpendicular lines from where the continuations of these sides touch the picture, and on them, from the ground line, G, L, place the height of the cube, as 1—2, which is the same as the width, and complete the square shown by the dotted lines: from all four angles of this square draw lines to the centre of view—this will give the representation of four lines at right angles with the picture carried on as far as it would be possible to see them; then it only remains to cut off the required perspective widths of the cubes by the perpendicular lines from the intersection of the visual rays with the plane of the picture: the completion of this problem will be very easy, if the drawing of the squares is well understood.

In such simple objects as these it will not be necessary to draw a plan; when one side is parallel to the picture their dimensions are known. In fig. 2, plate 3, the same objects as those in fig. 1 are drawn without a plan, thus:—

Draw the ground line, G, L, then the vertical line *s*, *c*, and the horizontal line d, c, d, the height of the eye; making d, d, the same distance on each side of c, that the eye is from the transparent plane; for drawing the squares, mark off from s to b', on the ground line, the distance that the square is on one side of the observer; let b', a' be the length of one side of the square; from b', a' draw lines to c', which represent the sides of the square carried on indefinitely, in order to cut off the required perspective width of the side b', e' of the square; place off the width, a', b', from b' to p, then draw from p to d on the left, and the points where the line d, p intersects b', c, in e', will give the apparent width required; then draw f', e', parallel to a', b', and the square is complete: this may be proved in the same way as those in fig. 1. The further square may be obtained in a similar manner, setting off the distance between the squares from p to q, and the width of the square beyond that, and drawing lines to d as before: some of the lines in this plate are not continued to the ground line, in order to avoid confusion. Proceed with the cubes by the same rule. Let 1, 2, 3, 4, be the size of one side of the cube if continued until touching the picture; from these points draw rays to c: from 3 to t set off the distance the cube is from the picture, and from t to v, the width of the cube; draw from these points to d, on the right, and their intersection of the line 3—c in m, o, will give the perspective width and position of that side of the cube: draw lines perpendicular to the ground line from m and o, and lines parallel to 4—2 from the angles of the cube, l', g', m; then draw the side, n, h', and the cube is complete. The whole operation of drawing the other cube is not shown, for reasons before stated.

In examining the plan of the foregoing figures, it must be observed that the angle contained between the lines S, D, and S, D, is a right angle, which is a proper angle to allow for the extent of vision; that is to say, no objects could be clearly distinguished if placed outside those lines; therefore, in making use of the rule, it will always be necessary to place the objects within the points of distance, D, D, nor should the horizontal line be higher than the eye is distant from the picture, for the same reason.

Having worked this problem, the pupil may place the cube in a similar position to the one just described, and proceed to draw its outline by his eye, according to the preceding rule. Commence by drawing a horizontal line for the base, marking upon it the points of the angles, to which draw perpendicular lines for the two sides of the end nearest the eye; these perpendicular lines should be the same length as the base line, and be connected by a horizontal line parallel to the base line; the outline of one side of the cube is then complete. The next thing to be done is to get the apparent inclination of the receding lines, by holding the pencil before the eye, in such a direction as that one edge of the pencil shall intersect the point of the angle, and inclining it until it follows the apparent direction of the side of the cube; retaining the pencil in precisely the same position, apply it to the corresponding angle on the paper, and there mark the points indicating the direction of the line: proceed in the same manner to get the inclination of the other lines. This done, it only remains to determine the apparent width of the other side, and of the top; to accomplish this, hold the pencil parallel to the nearest perpendicular line of the cube, and measure the apparent height of the cube on the pencil with the thumb-nail; then, retaining your hold of the pencil, and keeping it the same distance from the eye, turn it in a horizontal direction, having the part marked with the thumb-nail even with the near perpendicular line, and the point where the farther perpendicular line intersects the pencil will mark the apparent width in proportion to the height of the near perpendicular line.

It is extremely difficult to describe verbally even this method of measuring the relative dimensions and degrees of inclination of lines in an object; but once accomplished, the pupil will find the practice of this "rule of thumb" both simple and certain, and applicable to all purposes of sketching. The problems will enable him to prove the correctness of his drawing afterwards, as previously they will enable him to understand the principle of perspective drawing.

RULE FOR DRAWING AN OCTAGON IN PARALLEL PERSPECTIVE.

LET A, Fig. 1, Plate 4, represent the plan of an octagon: draw G, L,—S, C, and D, D, the same as before; from the points G, *a*, *b*, *e*, draw rays to C, place the distances *e*, *c*, *d*, *f*, from *e*, on G, L, from which draw lines to D, on the left, and where they intersect the line from *e* to C, draw horizontal lines across, corresponding to *c*, *g*,—*d*, *h*, and *f*, *i*, on the plan; now connect the angles on the perspective view, corresponding to *g*, *a*,—*b*, *e*,—*d*, *l*, and *k*, *h*, on the plan, and it is complete. The figure B is drawn in a similar manner, and by continuing perpendicular lines from the lower figure.

RULE FOR DRAWING AN OCTAGONAL TOWER IN PARALLEL PERSPECTIVE.

FIG. 2, Plate 4, is the perspective representation of an octagonal tower; the geometrical plan is omitted for want of room, but the perspective plan will be observed by the dotted lines: in order to render this example more clear, many references have been omitted, but it will be well understood after having gone through the foregoing examples. Octagons must be formed at *f*, *g*, *h*, and *k;* those at *f* and *g*, must be connected by the perpendicular lines, *a*, *b*, *c*, *d*, and *e;* those at *h* and *k*, by the perpendicular *l*, *m*, *n*, *o*, and *p*. The proper heights of the octagons may be set up on the line *r*, *s*.

After working this and each of the succeeding problems, the pupil may proceed to sketch the object; measuring the apparent dimensions and ascertaining the apparent inclinations of the receding lines, in the same manner as before described.

RULE FOR DRAWING A CIRCLE IN PARALLEL PERSPECTIVE.

Let *c*, Fig. 3, Plate 4, represent the plan of a circle, round which a square, *d*, L, *e*, *o*, is drawn: draw diagonal lines across the square, and where these intersect the circumference of the circle, draw the lines *b*, *k*, and *d*, *g*, and the lines *f*, *l*, and *c*, *h*, at right angles across the centre of the circle; from all the points in the line *a*, L, draw lines to C; set off the distances *a*, *b*, *c*, *d*, and *e*, on the line G, L, from *a*, and draw lines to the point of distance on the right; where these intersect the line from *a* to C, draw horizontal lines corresponding with the lines *b*, *c*, *d*, and *e*, on the plan: mark the points on the perspective representation, corresponding with the points *l*, *k*, *h*, *g*, *f*, *n*, *c*, *m*, on the plan, and through these points draw the curve as shown in the example, which is an ellipsis, and the perspective representation of the circle C. The figure D is drawn in the same manner, and being at a greater distance from the horizontal line, can be better distinguished.

After having drawn Fig. 3, and the octagonal tower Fig. 2, it will not be necessary to explain the cylindrical tower Fig. 4. All these examples should be drawn out to a large scale.

RULE FOR DRAWING A PYRAMID IN PARALLEL PERSPECTIVE.

LET A, Fig 5, Plate 4, represent the plan of a pyramid, the diagonal lines showing the upper angles of the same, and where they intersect is the apex: from G, *a*, draw lines to C, place the width of the pyramid on the ground line from *a*, and draw to D on the left, which will intersect *a*, C, in *b*, and is the perspective width of that side; from *b* draw a line parallel to G, *a*, which then completes the perspective of the square base of the figure; draw diagonal lines from G to *b*, and *a* to *c*, where they intersect gives the perspective centre of the square; upon this point raise a perpendicular line which is the axis of the pyramid; draw the perpendicular line *e*, *g*, in the centre of the line G, *a*, upon which set up the height of the pyramid, *e*, *f*, from *f* draw a line to C, and its intersection of the axis of the pyramid at *d* will give the perspective height; complete the figure by drawing lines from *d*, the apex, to G, *a*, and *b*, the three visible angles touching the ground. The other two pyramids are drawn in a similar manner, by setting their distances off from *a*, on the ground line, and drawing up to the point of distance on the left.

RULES FOR DRAWING A CONE, A PRISM, AND A CYLINDER IN PARALLEL PERSPECTIVE.

LET B, Fig. 6, Plate 4, represent the plan of a cone, which is exactly similar to the circle C, Fig. 3; therefore the perspective view of a circle will first be drawn, upon the perspective centre of which draw a perpendicular line, *a*, *b*; on the centre of the line *d*, *e*, raise a perpendicular, *c*, upon which set up the height of the cone, from the ground line to *c*; from *c* draw a line to C, and the point where that intersects the axis of the cone *a*, *b*, in *b*, will give the perspective height of the axis; from *b* draw lines to *f* and *g*, and the figure is complete.

For the prism, Fig. 7, which consists of two triangular ends and three rectangular sides, place the length of the side *a*, L, upon the ground line, and draw lines to C; mark off the width of one end from *d* upon the ground line, and draw up to the point of distance on the right, which gives the perspective width, *a*, *d*; find the perspective centre *f* of the side in the same way, and from *f* and *d* draw horizontal lines until they intersect the line from L to *c*; upon *f* and *g* draw perpendiculars; set up the height *a*, *b*, of the end of the prism, and from *b* draw a line to C, and the point where it intersects *f*, *c*, in *c*, will give the perspective height of the end of the figure; from *c* draw *c*, *e*, parallel to *a*, L, from *c* draw *c*, *d*, and *c*, *a*, and the visible end is complete; the other end is dotted in to show the process only.

Fig. 8 is the representation of a cylinder, with one end towards the spectator, and will be understood by examination.

RULE FOR DRAWING AN ARCH OR BRIDGE IN PARALLEL PERSPECTIVE.

LET A, Fig. 9, Plate 4, represent the elevation of one arch of a bridge, formed of two semicircular arches; divide the distance from *a* to *d* into any convenient number of parts, as seen at *a*, *b*, *c*, *d*; divide the other half of the arch from *d* to *g* in the same way, and from these points draw lines perpendicular to *a*, *g*: where these lines intersect the curve of the arch, draw the horizontal lines *h*, *k*, *l*. Let the distance from *d* to *m* be the height to the top of the bridge; now draw the lines G, L, and D, D. Make G, *n*, the width of the bridge, and draw lines from those points up to C, continue the perpendicular lines intersecting the elevation of the arch until they touch the line G, L; draw lines from those points to D on the left, and where they intersect the line *n*, *o*, draw perpendicular lines corresponding with those in the elevation; on the line *n*, *n*′, place the distances, *n*′, *h*′, *k*′, *l*′, *n*′, equal to those in the elevation, from which draw lines to C, and their intersection of the perpendicular lines corresponding to those in the elevation will give the perspective points in the curve; mark these and draw the curve through by hand. The further arch is drawn in the same way, by placing the distances *a*, *b*, *c*, *d*, *e*, *f*, and *g* upon the ground line, to the right of the nearest arch, and drawing lines to the same point of distance. To obtain the appearance of the visible part of the other side of the bridge, proceed as follows: from the intersections on the line *n*, *o*, draw horizontal lines until they intersect the line from G to C, on which line draw perpendiculars, corresponding with those in front of the arch; now draw horizontal lines from the points in the perspective curve until they intersect the perpendiculars last drawn, which will give the points in the curve corresponding to those on the front of the bridge.

Fig. 10 is a representation of an elliptical arch; the same rule is applicable here as in Fig. 9, and the references are the same as in that figure.

On account of the small size of these plates, and the desire to compress a great quantity of information in a small space, as few references as possible have been made use of; for if the student well understands the few first problems, the apparent difficulty of understanding those more complex will be entirely surmounted.

RULE FOR DRAWING A SQUARE AND A CUBE IN ANGULAR PERSPECTIVE.

LET A, Fig. 1, Plate 5, represent the plan of a square, and B the plan of a cube, of which a perspective representation is required. Place the station point S in a convenient position to view the two, to which draw rays from *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h*; divide the angle *a*, S, *g* in C, and draw V V at right angles to S, C, or which is the same thing, make it parallel to the line *k*, *l*; make S, V, and S, V, parallel to *h*, *g* and *d*, *c* on the right, and *e*, *h* and *a*, *d* on the left. Draw G, L parallel to V V, and *v*, *v* parallel to G, L, for the horizontal line; then draw down perpendicular lines from where the rays intersect V, V. For the square, draw lines from *d′* to *v*, *v*, and where they intersect the perpendiculars from the angles at *a′* and *e′*, draw lines again to *v*, *v*; if it is correct, they will intersect in the point *b′*, and the square is complete.

As the cube is some distance from the transparent plane, it will be necessary to continue either the side *e*, *h*, or *g*, *h*, until it touches V, V in *m* or *n*; but here we have shown both: drop down perpendiculars from *m* and *n*, and upon them set up the height *m'*, *o* or *n'*, of the cube, and draw lines to *v* and *v*, they will intersect the perpendicular line from the angle *h* in *h'*: from these intersections again draw lines to *v*, *v*, and where they touch the perpendiculars from the rays *e* and *g*, will mark the extent of two sides of the cube; from *q*, *r*, again draw lines to *v*, *v*, and the figure is complete.

RULE FOR DRAWING AN OCTAGONAL AND CYLINDRICAL TOWER, AND A PYRAMID, IN ANGULAR PERSPECTIVE.

LET A and B, Fig. 2, represent the plans of an octagonal and cylindrical tower, and C the plan of a pyramid; make S the station point, and draw rays from the plans to S; make S, V and S, V, parallel to *i*, *m*, *e*, *h*, and *d*, *c*, and *i*, *k*, *e*, *f*, and *d*, *a*; make V, V parallel to *n*, *o*. The parts on the plan that are etched over, show the plan of the small parts of the towers, the outer lines the plan of the caps. Draw G, L, and *v*, *v*, and draw down perpendicular lines from the intersections of the rays with V, V. For the towers it will only be necessary to direct the student to examine the examples, if he well understands the instruction previously given; for these plates are necessarily so small that numerous references would tend rather to confuse than direct him. For the pyramid, proceed and draw the square base in the same way as the square in the last plate; then draw a line from the centre of the plan of the pyramid, parallel to *i*, *k*, until it touches the line v, v; drop down a perpendicular line, upon which set up the height of the pyramid as *p*, *q*, draw from *q* to *v* on the left, and the point where the line intersects the axis of the pyramid will be the perspective height required; from the apex draw lines to *k*′, *i*′, *m*′, and the figure is complete.

RULE FOR DRAWING A BRIDGE IN ANGULAR PERSPECTIVE.

LET A and B, Fig. 1, Plate 6, represent the plan of the two piers of a bridge, consisting of two semi-elliptical arches, of which only one and a part of the other are here shown, for want of room; but it will be seen that the rays are carried down from the other parts which are not shown upon the plan. Draw the curve of the arch by the rule given in Fig. 8, Plate 2, and divide the width of the arch, as *b*, *c*, *d*, *e*, *f*, *g*, *h*; carry up lines perpendicular to *b*, *h*, until they cross the curve of the arch, at which points draw the intersecting horizontal lines, as *k*, *l*, *m*, and let *o*, *p* be the height to the top of the bridge. Fix the station point S at a convenient distance from the object, draw down the rays from *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, &c., to S; divide the angle *q*, *r*, S in C, and make V, V at right angles to S, C. Make the line S, V, on the right, parallel to the front of the bridge, and S, V, on the left, parallel to the end; their intersection with the plane of the picture gives the vanishing points for the front and end of the bridge. Draw G, L parallel to V, V, and make *v*, *v* parallel to G, L, and the height of the eye; let fall perpendiculars from where the rays intersect the transparent plane, and also from V, V; then v, v will be the vanishing points in the perspective representation. Upon the perpendicular line from the nearest angle t of the bridge, set up the height o, p, from G, L, as o', p'; from these points draw lines to the vanishing points; set up the heights k', l', m', of the intersecting lines of the arch upon the same line as o', p', and draw to v on the right, and their intersections of the perpendiculars from b, c, d, e, f, g, h, will give the required points in the perspective curve of the arch: the visible part of the curve on the other side the arch is gained by drawing from g', h', to v on the left, and their intersections of the line from a to v on the right will give on that side the points corresponding to g', h'; on the point from g', draw a perpendicular, and draw a line from the point in the curve above g' to v on the left; and where that intersects, the perpendicular line just drawn will indicate one point in the curve, which is all that can be seen: the remaining part will be easily understood by observing the example.

GENERAL HINTS ON LIGHT AND SHADE.

Shadows are of two kinds, natural and artificial. Natural shadows are those produced by the sun. Artificial shadows are those produced by a lamp or candle, &c.

Light is supposed to be emitted from all luminaries in straight lines or rays, and those from the sun are apparently parallel on account of his great distance from us.

The parts of an object immediately opposed to rays of light are said to be in light, as *a*, *a*, *a*, *a*, Figs. 2 and 3, Plate 6.

When an object standing on anything intercepts the sun's rays, the darkened spot is said to be in shadow, as *b*, *b*, *b*, *b*, Figs. 2 and 3, Plate 6; the parts *c*, *c*, *c*, *c*, in shade.

That part of an object which is nearest to the light will be the lightest, and on the contrary that part which is farthest from the light will be the darkest, if not influenced by reflected light from adjacent objects. The parts marked *c* in Figs. 2 and 3, will not be so dark as those marked *b*, because the light thrown by the rays, *d*, *d*, *d*, *d*, will be partly reflected back, and those surfaces will receive it; but however strong the reflected light may be, it can never be so bright as direct light. Shadows are much darker when they fall upon the lightest parts of an object: see the cylindrical and octagonal towers, Fig. 2. The shadows cast from the caps of the towers appear much darker on the lightest parts than the shades in any other part of the figures. Shadows cast upon the ground will be much darker the nearer they are to the object that causes them.

In Fig. 2, Plate 6, the sun is supposed to be in a direction parallel to the picture, and elevated to the angle shown by the lines *d*, *d*, *d*, *d*; by drawing lines in the direction of the sun's rays from those parts of the figures which touch the ground, their intersection with the rays, *d*, *d*, *d*, will give the boundary or extent of the shadow.

In Fig. 3, Plate 6, the shadows are cast by a candle: it will be seen that the rays, *d*, *d*, *d*, diverge from the light, and are shown crossing the corners of the cubes, &c., here represented; by dropping down a perpendicular line from the luminary until it is supposed to touch the ground in the centre of the lower side of the cube upon which it stands, and from that point drawing lines crossing the lower angles of the different objects, the point where those lines intersect the corresponding ones from the light will mark the extent of the shadow. This will be better understood by placing the objects in the same light and shade, and comparing them with the example.

In filling-in the outline of a figure with its component parts of light and shade, the pupil should be directed to draw the lines which indicate the shade close to and even with each other, and to give them a direction parallel to the sides of the object. To produce a proper gradation of depth in the shading, so as to express the effect of reflected light thrown upon the shaded side of an object, and to soften the edges of shadows, demands care and delicacy of hand, only to be acquired by practice. In drawing the sphere, the shading lines must all have a circular direction, and the gradations of light and shade will require to be very tenderly marked: observing that from the brightest light it gradually declines to deep shade, until the shade is influenced by the reflected light thrown upon it by the surface on which it rests.

The sphere will, moreover, serve, better than any other figure, to exemplify the effect of light and shade in representing the forms of solid objects; and also, to illustrate the fact that outline is merely the edge or boundary of substance, defining its shape as it is seen relieved against the atmosphere or other objects. This is important to be borne in mind; because, in a perfect delineation, the outline first drawn is lost by the subsequent shading; and thus it is proved that to express the relief or rotundity of an object completely, no distinct or separate line should be visible at the edge. For instance, if the circle first drawn to define the sphere be not softened down, and subdued to the tint of the light and shade within it, the sphere will look like a hemisphere only; its edges appearing to stick to the background.

THE END.

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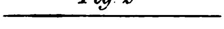

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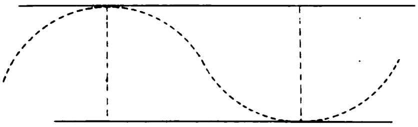

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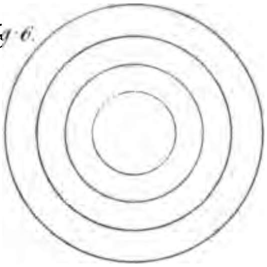

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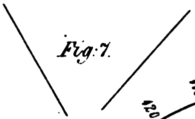

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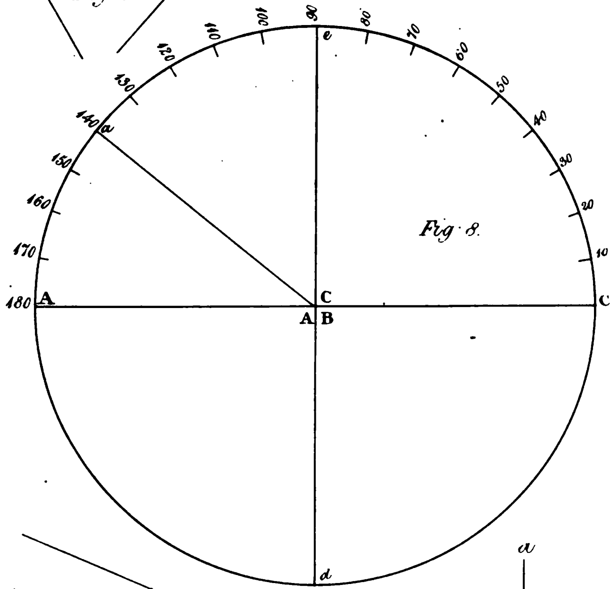

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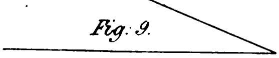

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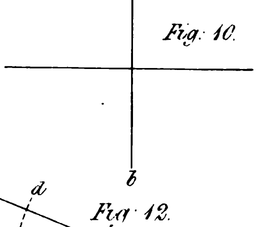

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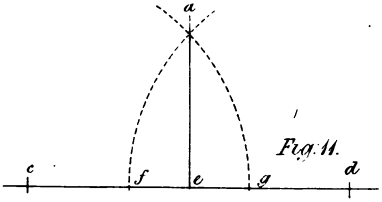

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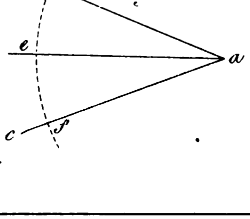

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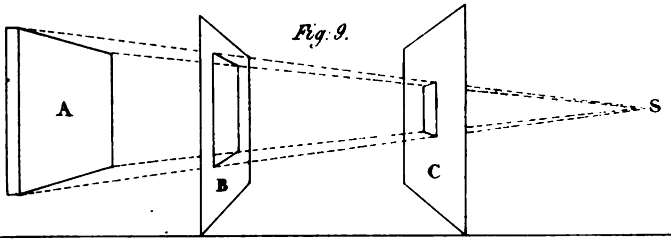
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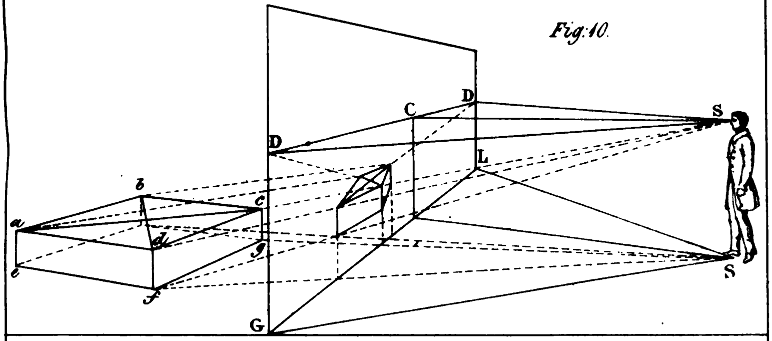
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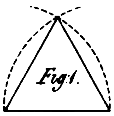
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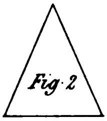
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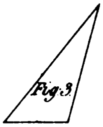
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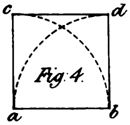
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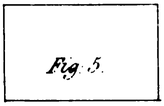
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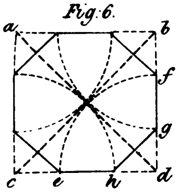
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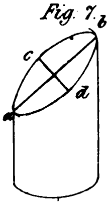
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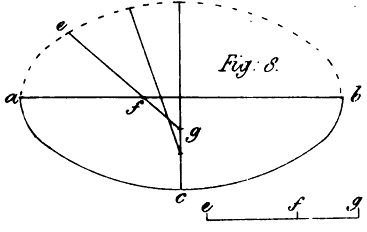
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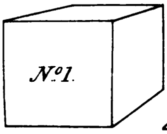
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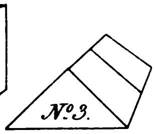
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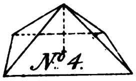
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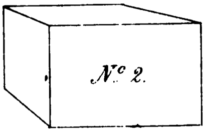
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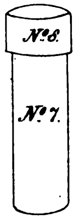
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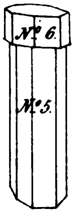
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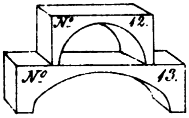
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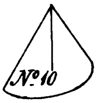
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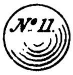
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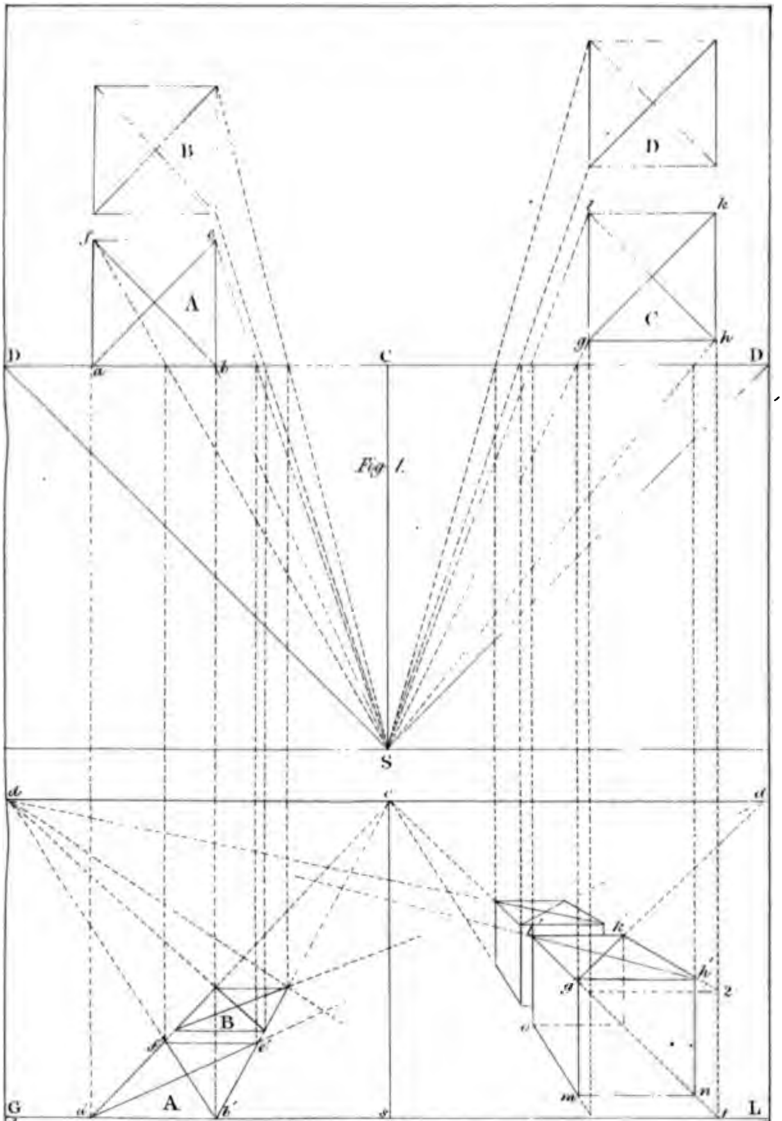

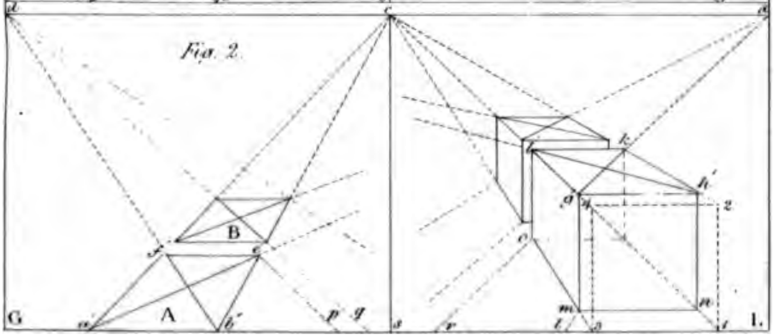

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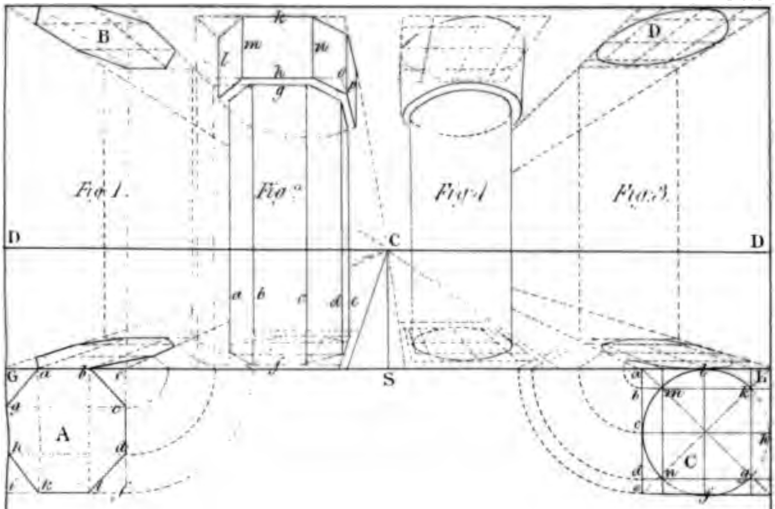

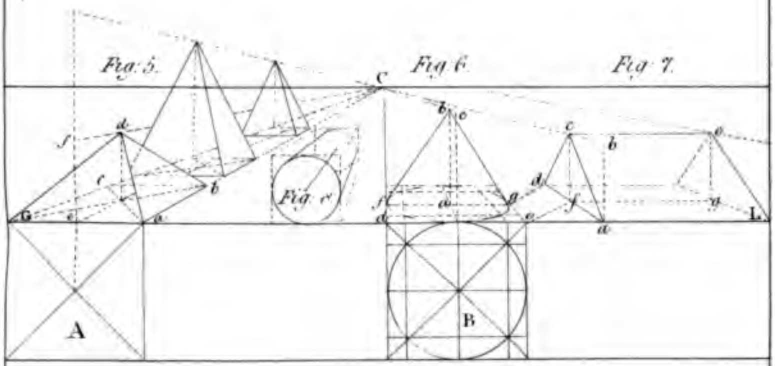

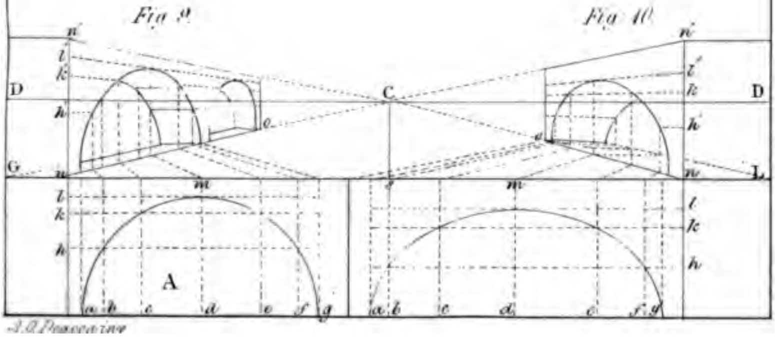

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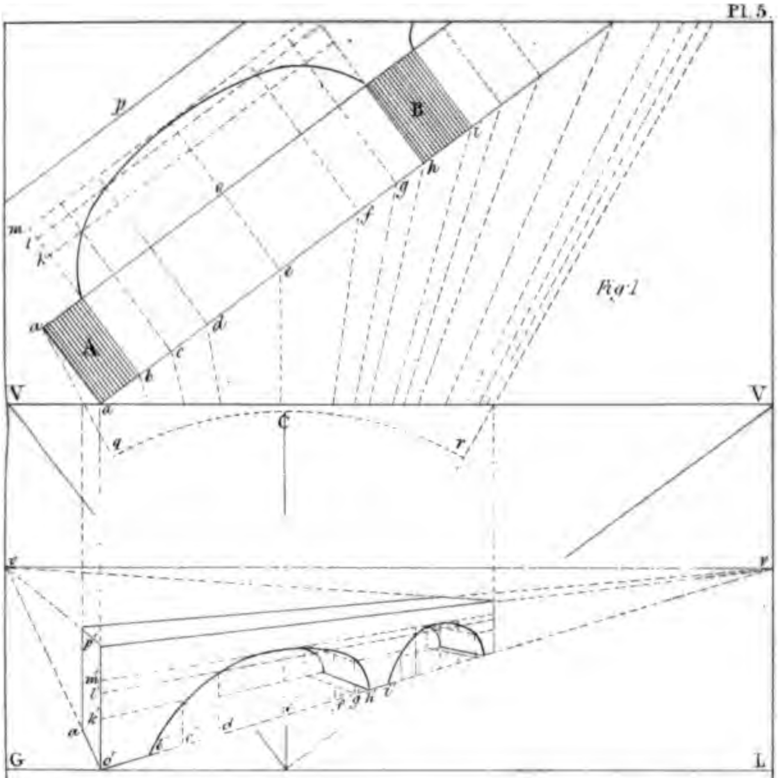

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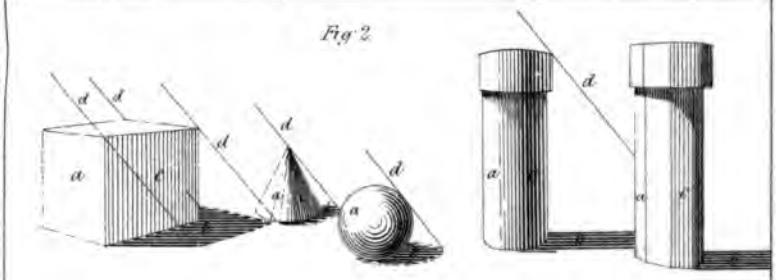

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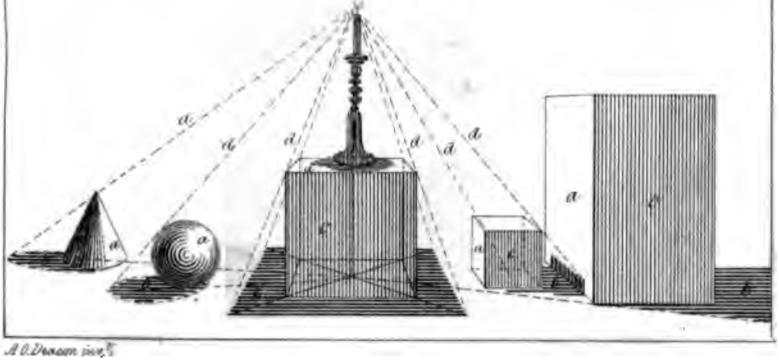

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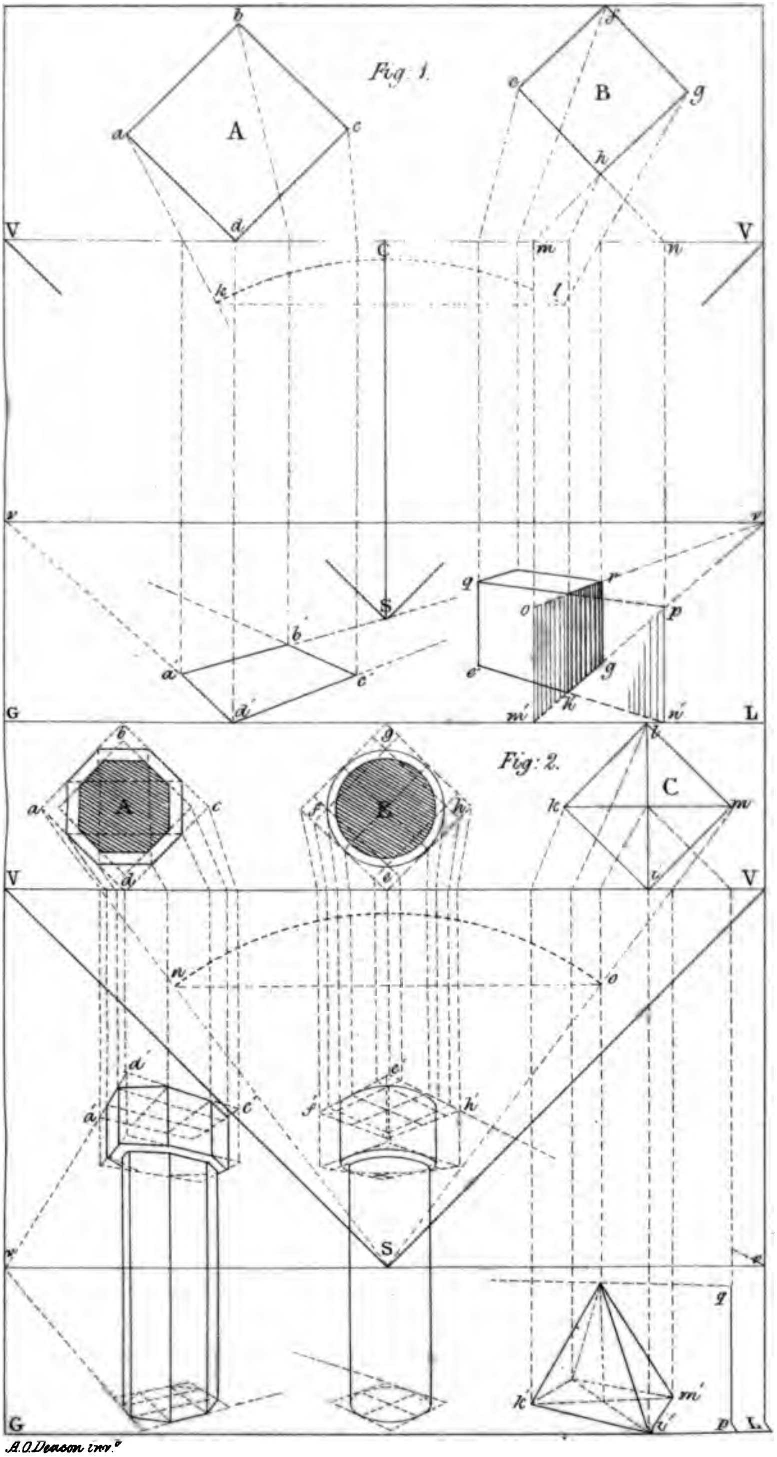
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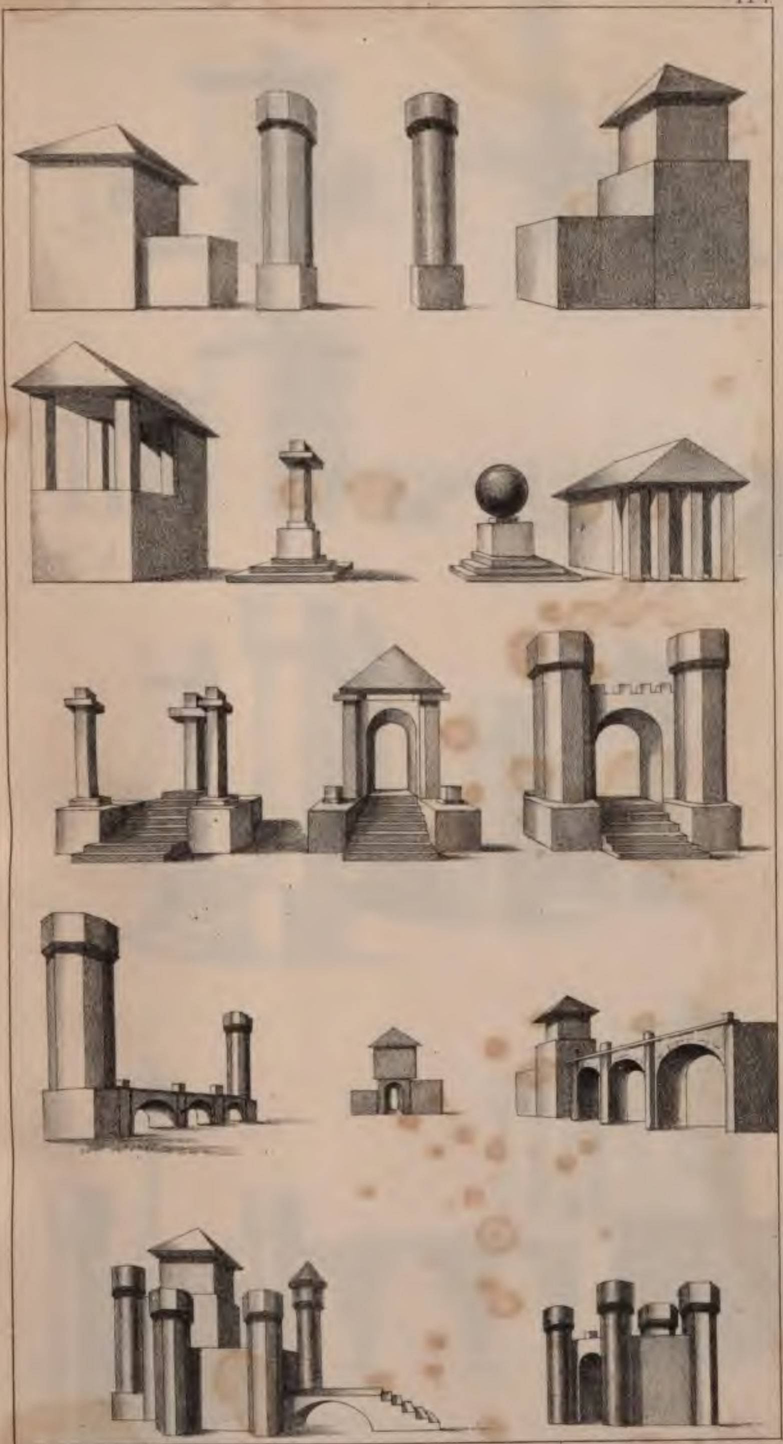

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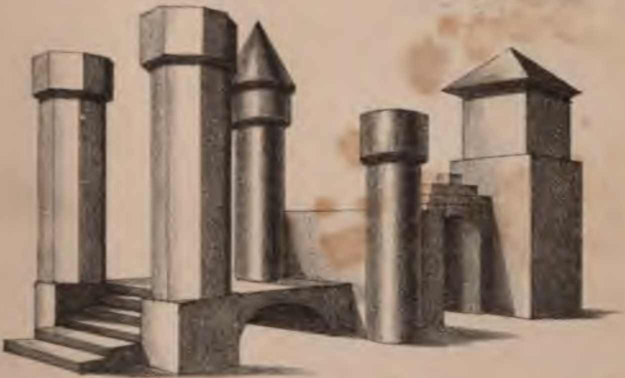
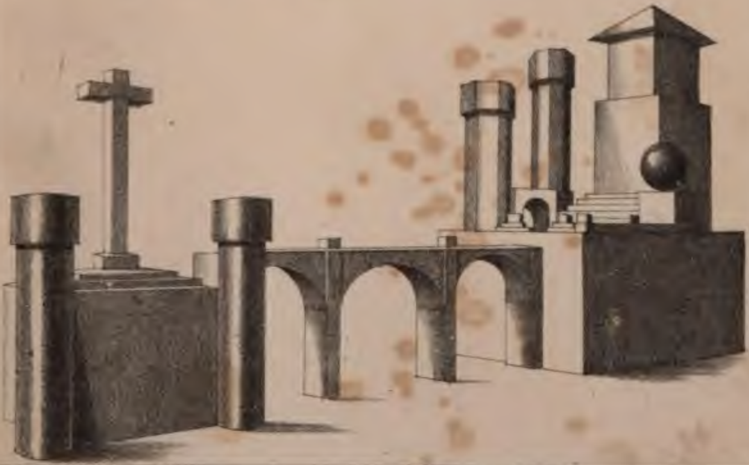
Pl. 8.





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